UNIVERSITY OF DELAWARE

DEPARTMENT OF CIVIL ENGINEERING

PROGRESS REPORT
OF THE
WATER QUALITY INVESTIGATIONS
AT THE
TYBOUTS CORNER SANITARY LANDFILL

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Progress Report of the
Water Quality Investigations at the Tybouts Corner
Sanitary Landfill

Scope

In the agreement between the New Castle County Public Works Department and the University of Delaware to evaluate the water quality changes at the Tybouts Corner Sanitary Landfill Operation, one of the many stipulations was to submit to the County a preliminary progress report of the water quality evaluations. This report presents the water quality data collected up to July 17, 1969 and analyzes the results.

Background

This report is based on the weekly water sampling and analyses of the 13 wells drilled into the landfill area, whose positions are marked on Figure 1. Any noticeable change in water quality in these wells would be indicative of leachate movement from the solid wastes above. Samples collected were centrifuged to remove sediment and the clear supernatant was used for analyses.

During the course of filling up of the landfill several wells P-1, P-4, P-5 and P-12) were damaged or did not have any water available for sampling. Therefore, some of these well water quality data were not available continuously.

In addition, samples were collected from wells in houses adjacent to the landfill. The approximate positions of these house water sampling locations are also marked in Figure 1.

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The house water samples were collected to determine any long term water quality changes in the area due to the landfill.

Further, surface water samples from Pigeon Run, Red Lion Creek and the gravel pit ponds were also collected for analyses. These surface water sampling locations are (S-1 to S-8) also marked on Figure 1.

Hydrologic Evaluation

The hydrologic investigations are concerned with the rate, direction, and magnitude of the ground-water flow from beneath the landfill area to discharge areas. The depth to water in each well is recorded whenever a water sample is obtained. These data will be used to construct the piezometric surface beneath the landfill and in the general vicinity. When equilibrium conditions have been established, this map will indicate the direction of ground-water movement and changes of the water surface with time will indicate the volume of water discharged from the area.

A new observation well drilled near well P-3 but outside the landfill will be used to monitor water levels on a continuous basis. In addition, a controlled test, where the new well would be pumped and dye injected into well P-3, is planned in order to determine the aquifer parameters in the vicinity of well P-3. This information will then be used to predict the time of travel of the ground water from the landfill to Pigeon Run under the established hydraulic gradients.

Additional drilling has established the existence of a thick clay section directly beneath Pigeon Run. This clay will act as a perching layer to the ground-water flow and cause the ground-water to discharge into Pigeon Run rather than flow under the stream toward the south.

It should be noted, however, that the movement of ground water toward Pigeon Run does not necessarily mean that pollutants will reach Pigeon Run. There is every reason to believe that attenuation of the pollutants will occur during the movement through the soil. This, in fact, is one of the most important aspects of the study - the determination of the fate of the pollutants with time and distance.

Discussion of Results

Landfill Ground Water Quality Studies

Monthly reports of the ground water quality analyses of the wells in the landfill area were supplied to New Castle County for their records. These monthly progress reports form a part of this report and a copy of the tabulated data for all the wells has been included here up to July 17, 1969.

Water quality data for each individual well have been plotted on graph paper. Figures 2 through 13 show at a glance the results of water quality analyses of the wells in the landfill area.

Although the ground water quality analyses consisted of some 12 parameters, some were analyzed weekly, others biweekly or

monthly. The most critical parameters for assessing the leachate movement in a landfill have been found to be chlorides, specific conductance (total dissolved solids), sodium and iron (1) (2) (3). In our particular experience we found this to be true, i.e. chlorides and specific conductance were indicators of water quality changes in the ground water beneath the landfill. There was a very definite correlation between these parameters if long term trends were observed instead of isolated data.

The water quality of wells P-1 to P-7 and P-13, over which solid wastes have been deposited, has shown some degradation with time. The quality in wells P-8 to P-11 remained fairly constant except in some cases (P-8 & P-11) where there has been a decrease in the concentration of some parameters (chlorides and specific conductance) with time, i.e. water quality has improved. The reason for this improvement in water quality for these wells is not apparent.

In the section below, the water quality changes of only wells P-1 to P-7 and P-13 will be discussed since the solid waste deposition is over these wells and consequently leaching of materials can be expected to affect the water quality directly underneath. It may take some time to find leachate in distant wells since ground water movement if fairly slow.

Chlorides

Generally, there has been a steady increase in the chloride concentrations to a maximum value, followed by a steady decline.

Figures 3 & 4 (wells P-2 & P-3) represent this typical trend. Apparently, chloride is one of the easily leachable ions from the solid wastes and it has low affinity for soil or other surfaces, so it finds its way into the ground water fairly readily. The experiences of other investigators also confirm this fact. (1). The level of chloride build up nowhere exceeded the very stringent USPHS Drinking Water Standards (4) of 250 mg/l, and so does not constitute pollutional levels. The current highest concentration of chlorides (July 17, 1969) of 43.4 mg/l was in the well P-2, and this was still fairly low.

Specific Conductance

As mentioned earlier the long term trend of the specific conductance data of the water samples followed the pattern set by the chloride data. For example in well P-3 (Figure 4) it remained fairly constant at about 90 µmho/cm, up to the first week of March 1969, and then started to increase as the solid waste was being filled near this spot. It went up to 250 µmho/cm in late April which was more then twice the original value. Thereafter, it started declining and in mid July 1969 it was about 150 µmho/cm. The buildup of specific conductance was nowhere near the values of 1700 µmho/cm reported by other investigations (1), and so does not constitute any serious water quality problem.

Iron

Iron concentrations plotted in the tables and figures are for soluble iron only. No attempt was made to determine the total

iron of the samples because the well samples invariably contained different amounts of soil sediment and iron leaching from the soil was a possibility which would have complicated the results.

The iron levels in all wells fluctuated somewhat, but the average concentration was usually below the allowable limit of 0.3 mg/l set by the USPHS drinking water standards (4), except in well P-10. At times in well P-10 iron levels of as high as 3.3 mg/l have been recorded, but the reason for these high values is not clear since this well is away from the present dumping site (as of July 1969). There is a possibility of iron pickup from the rusting and solubilizing of the galvanized well piping.

There was no clear indication that iron was being leached out from the solid wastes. In well P-2 there was hardly any iron at the start, with time there was very slight buildup but in late June it was practically zero again. On the other hand in well P-3, at the start there was 0.3 mg/l of iron and there was actually a decrease in the iron level with time. Further, high iron levels in ground water are not a health hazard and many water supplies in New Castle County have fairly high iron levels (0.8-1.0 mg/l).

Nitrogen (Nitrate & Ammonia)

Only ammonia and nitrate nitrogen tests were run on the well water samples. Nitrate is an important ground water quality parameter since high nitrate (>10 mg/l NO_3--N) may cause the

disease methemoglobenemia in very young infants (4). Nitrate levels were fairly high in wells P-1, P-2 & P-7 which were the wells bordering the landfill boundary on the north and northeast side. Even before the landfill was operative (January 2, 1969), the nitrate concentration was high in these wells, which would indicate that natural ground water in the area has high nitrates. This has been confirmed by the data of the well water from adjacent houses. Although there was some slight initial buildup of nitrate in most wells, later there was generally a gradual decrease to levels usually below the starting values. Well P-2 started out with a nitrate concentration of 9.8 mg/l, (just barely below the allowable USPHS drinking water standards of 10 mg/l), it increased to a maximum of 13.4 mg/l, but a gradual decline has brought it to 5.6 mg/l on July 17, 1969. In most cases the decline in nitrate has been associated with an increase in ammonia concentration. Presence of ammonia in the well waters indicates a reduction of oxidized species under the anaerobic conditions prevailing in the landfill. Such anaerobic activity is to be expected in the landfill. Movement of ammonia in the leachate through the soil will be retarded because of ion-exchange and sorption reactions, and its presence, although undesireable, has practically no health implications at the low levels reported here (up to 10 mg/l). The decreased nitrate levels in most of the wells also do not cause any health hazards.

BOD

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The BOD data have been quite erratic and no worth while

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conclusions can be made of the data. The BOD data were quite unreliable because even before the start of the landfill several wells indicated substantial BOD's (as high as 39.6 mg/l in well P-2 on January 2, 1969), which was quite unexpected. However, it seems from the current data (July 12, 1969) of well P-3, that there has been an increase in soluble organic content of the water. BOD values on repeated examination of the samples were found to be around 50 mg/l. This would indicate a local contamination of the water underneath well P-3. Apparently, leachate containing soluble organics has locally seeped around the well point giving a high BOD. If there had been an areal contamination then well's P-2, P-13 etc. would also show high BOD values.

Based on the BOD, the ammonia and other tests results on wells P-2 & P-3, it seems that these wells are the two most critical ones. There seems to be a local change in ground water quality around these wells, which needs close observation in the future.

Other Parameters

Alkalinity, acidity, hardness, pH and orthophosphate measurements were also made on the water samples. Generally, these tests do not give a very good indication of the leachate movement but in some specific cases they have given some clue as to what kind of quality change has occurred in the ground water underneath the landfill.

There was an apparent discrepancy in pH results. No change in pH was observed in wells P-2 and P-3, the two critical wells, but

pH increased significantly in the wells P-5, P-6 & P-11 for some unknown reason. The increased pH to 9.0 - 9.5 has no public health significance but it affects the chemical equilibrium of the water.

House Ground Water Quality

Samples should have been collected from these houses before the start of the landifll operation in order to be absolutely certain that the water quality changes in these wells could be related to the landfill. However, this was not done.

Water samples were taken from four houses adjacent to the north side of the landfill on April 18, 1969. Most of these houses are at least 200-500 feet away from the landfill boundary. The sample H-1 (Stevens House) was not of very high quality. The low quality of sample H-1 must be due to natural causes since there was little possibility of pollutants traveling from the landfill upgrade in such a short time (4 months). Possibly septic tank seepage from this house is causing the well water quality deterioration.

Water quality of the sample H-2 (Wolfe House) was better than H-1 but still it had high nitrates. The other samples, H-3 (Barnes House) and H-4 (Webb House), had an excellent water quality.

A repeat sampling on June 27, 1969 of the Stevens and Wolfe wells confirmed the earlier data.

Stream Water Quality Results

Water samples were taken at S-1 (gravel pit pond no. 1), S-3 (gravel pit pond no. 3), S-4 (Pigeon Run), S-5 (Red Lion Creek

near route 13) and S-8 (Pigeon Run) at the location shown in Figure 1. The first sampling was done on April 18, 1969. These samples indicated that the gravel pit pond waters were of reasonably good quality, but that Pigeon Run before it entered the gravel pit site had some indication of bacterial contamination, which gradually decreased downstream at S-8. There was some pickup of phosphate 0.15 mg/l in Pigeon Run during passage through gravel pit area, but Red Lion Creek also contributed some phosphates which caused some increase at S-5. The levels of all other constituents of the water tested were normal and showed no influence whatsoever of the landfill operation.

A repeat sampling on June 27, 1969 confirmed the earlier conclusion that the landfill operation was not affecting the stream water quality at all. However, the bacteriological data indicated that Pigeon Run was grossly contaminated before it even entered the gravel pit. Passage through the gravel pit area reduced the coliform count by a factor of eight and it reached an even lower value at S-8 (near route 13). The phosphate data were much lower than reported earlier but they followed the same trend.

CONCLUSIONS

1. Based on about 7 months of water quality analyses of ground water in the landfill area, it can be said that there has been no major contamination of the ground water. Some leachate has been introduced into the ground water but the levels of contaminants are quite low.

2. Chlorides and specific conductance have been found to be the most suitable parameters to measure leachate movement.

3. Nitrate nitrogen is naturally high in some of the well waters. Nitrate concentration was found to be decreasing with time but ammonia concentration on the other hand was increasing. No health hazard seems to be present due to the presence of these chemicals at the levels present.

4. Some indication of localized soluble organic matter leaching into the ground water near well P-3 was observed. A close observation of this and other wells nearby will be made in the future. No indication of areal organic contamination was observed.

5. The water quality of the adjacent houses has not been affected by the landfill operations so far.

6. The stream water quality in the neighborhood has also been unaffected by the landfill operations so far.

References

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